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FORM PTO-1390 (REV. 12-2001) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: COLLI.P-33

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/089121

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/AU00/01160	23 SEPTEMBER 2000	24 SEPTEMBER 1999

TITLE OF INVENTION: COOLING OF MOLDS

APPLICANT(S) FOR DO/EO/US: Malcolm Barry JAMES

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [X] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/089121		

21. ☒ The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1040	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	43 - 20 =	23	x **$18.00**	$ 414	
Independent claims	5 - 3 =	2	x **$84.00**	$ 168	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$ 280	
TOTAL OF ABOVE CALCULATIONS =				$ 1902	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$ 951	
SUBTOTAL =				$ 951	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 951	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 951	
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 951 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 10-100. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

SIGNATURE

R. HAROLD NISSEN

NAME

Reg No. 17283

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Customer No.: 30294

Docket No.: P-33

Applicant: Malcolm Barry JAMES

Serial No.: National Phase of PCT/AU00/01160 having International filing date of 25 September 2000

Filed:

For: Cooling of Molds

Assistant Commissioner for Patents
Washington, D.C. 20231

PRE- EXAMINATION AMENDMENT

Sir:

Prior to the calculation of the filing fee, please amend this applications as follows:

March 21, 2002

IN THE CLAIMS

Please cancel all of the claims 1 to 29 filed with the PCT Application and add the following new claims.

30. A mold which includes an arrangement to assist in controlling of a temperature of the mold

including at least one closed chamber within the mold,

the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber,

at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and

condensing means by reason of heat exchange to effect condensation of vapour within the chamber, the mold being characterized in that the liquid is arranged, in use, to be distributed in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.

31. A mold as in the preceding claim wherein the different heights of

liquid are achieved by having at least one reservoir within the chamber with a bottom of the reservoir being above a bottom of the chamber.

32. A mold as in either one of the preceding claims wherein the different heights are achieved by having the liquid being applied as a surface application onto an inner surface of the chamber and above a base level of liquid within the chamber.

33. A mold as claimed in claim 30 wherein the different heights are achieved by having a passageway with some of the liquid in the passageway where an inlet at least to the passageway is above a base upper level of liquid in the chamber.

34. A mold as claimed in claim 30 wherein the different heights are achieved by having the liquid selected or having an additive whereby to effect a foaming.

35. A mold as claimed in claim 30 wherein the liquid includes a foaming agent.

36. A mold as claimed in either of claims 30 or 31wherein the liquid is predominantly water and the foaming agent is a surfactant.

37. A mold as claimed in claim 30 or 31 wherein there is a passageway for liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereinto.

38. A mold as claimed in claim 30 or 31wherein there is at least one reservoir for liquid in said chamber which is adapted to hold liquid so that a head of liquid in such a reservoir is less than the height of such liquid above other liquid in the chamber.

39. A mold as claimed in claim 30 or 31 wherein there is provided a substantially vertical conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in the chamber.

40. A mold as claimed in claim 39 wherein there are means to gather liquid within the chamber but at a height higher than an entry position into a conduit shape and means to effect through an injector conduit, a supply of

such liquid through the injector conduit into the conduit shape.

41. A mold as claimed in claim 30 or 31 wherein there is a reservoir beneath an area providing for condensing of any vapour within the chamber and a conduit extending from such a reservoir down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.

42. A mold as claimed in claim 30 or 31wherein there is provided a conduit which forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding reservoir.

43. A mold as claimed in claim 42 wherein there is provided in an adjacent vicinity to the conduit, a means to provide a source of heat.

44. A mold as claimed in 30 or 31 wherein there is provided at least one dam or reservoir which holds a limited amount of the liquid and which is arranged to collect the liquid from time to time during the boiling of the liquid

in the chamber either by reason of rapid transition to vapour effects causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

45. A mold as claimed in claim 30 or 31 wherein the reservoir or dam or darns are arranged to overflow as they are filled with the liquid and such then that this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head pressure and therefore maintain a reasonably small range of temperatures at which the liquid will boil within that selected reservoir or dam.

46. A mold as claimed in claim 30 or 31 wherein there is applied, a surface material to an inner wall of the chamber.

47. A mold as claimed in claim 30 or 31 wherein at least some parts of the inner surface of the chamber are coated with a material such that surface tension implicit between the liquid and the material will assist in continuing retention of the liquid against the wall.

48. A mold as claimed in claim 30 or 31 wherein flock in the form of a number of short strands of fiber is attached end on in close vicinity one to the other, to the surface so that liquid which reaches any such selected area thus treated, will be held to be of greater depth and therefore act as a greater reserve.

49. A mold for molding of plastics material where there is a closed chamber using the heat transfer system described to effect a transfer of heat, wherein at least some of the surface of the chamber has attached thereto further material or materials to assist in retention of the liquid in the adjacent vicinity of a target surface of the wall of the chamber.

50. A mold as claimed in claim 49 wherein the liquid is water.

51. A mold as claimed in claim 50 wherein the foaming agent is a foam causing surfactant.

52. A mold as claimed in claim 30 or 31 or wherein replenishment is effected by foam causing film of the liquid to pass across the selected surface area wetting this thereby.

53. A mold as claimed in claims 30 or 31 wherein there is a passageway connecting with liquid in the chamber which passageway is closed at an upper end and which has at least a portion which can be seen through to the extent that any liquid level within the passageway can be externally determined and the position of the passageway including its entry and its closed upper end, is such that a level of liquid within the passageway will change from a first level where a first evacuation status within the chamber exists, to a second level where the degree of evacuation within the chamber is less than the first said evacuation status.

54. A method of effecting heat transfer within a closed chamber of a mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and where the liquid level is at different heights within the chamber.

55. A method of effecting heat transfer within a closed chamber of a

mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

56. A method of effecting heat transfer within a closed chamber for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of liquid within a space above the liquid within the chamber, and where a surface of the chamber or condenser for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

IN THE SPECIFICATION

March 21, 2002

After the Title and between lines 1 and 2, insert the following:

This application claims Paris Convention priority of Australian Applications Nos. PQ 3077 filed September 24, 1999, and PQ 3334 filed October 11, 1999 the complete disclosures of which are hereby incorporated by reference, and priority of International Application number PCT/AU00/01160 having International filing date of September 25, 2000.

Page 1, between lines 10 and 11, please insert the following.

The previous patent application referred to in line 7 of the above paragraph and in line 17 of Page 14 is U.S. Patent Application Serial No. 09/719,136 filed in the United States on April 4, 2001 and was published in International Publication number W0 99/64218 on December 16, 1999.

IN THE DRAWINGS

Submitted herewith is a copy of Figure 1 of the drawings which includes added reference numerals 4a and 9 omitted from the drawings filed in the PCT application from which priority is claimed.

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REMARKS

The above amendment to the specification is submitted to include the cross-referencing of the Australian priorities and the PCT priority desired for the United States no new matter is added, and entry into the application is earnestly solicited.

The other amendment for the specification relates to an earlier filed application of the inventor of this application.

The drawing correction was noted when the application was reviewed before filing.

In the event that a charge or credit is to be made relative to this subject patent application, then same may be charged or credited to attorney's Deposit Account No. 10-0100.

National Phase of
PCT/AU00/01160
P-33

March 21, 2002

Respectfully submitted

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Fig. 1 of Drawings (Amended)
Stamped return post card
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10/089121

WO 01/23158 PCT/AU00/01160

IMPROVEMENTS RELATING TO COOLING OF MOLDS

TECHNICAL FIELD

This invention relates to cooling of molds.

Such molds can include molds of a type useful for molding of materials of a type including injection molding of plastics materials.

BACKGROUND ART

There has previously been described in a previous Patent Application, an arrangement in which there is a chamber within a mold which is partially filled with a liquid and a remainder of the chamber is filled substantially only with the vapour of the liquid.

There is arranged a condensing arrangement positioned above a level of liquid in the chamber in relation to a source of heat within the chamber so as to cool and condense thereby vapour formed as a result of conversion from the liquid from the source of heat.

This arrangement has been found to have significant advantages in keeping temperatures of portions of the mold at relatively similar temperatures and therefore those parts of the mold that are used for defining the shape of a molded article and are required to be cooled from time to time to assist in the cyclic use of the mold. Such an arrangement can keep the mold at a more uniform and even temperature through its usage cycles.

One of the problems encountered has been that the head of any liquid within the chamber causes the liquid at a deepest point within a body of the liquid to be implicitly under a higher pressure and therefore the liquid at greater depth will "boil" at a higher temperature than the liquid at lesser depth. This then will result in temperature differences where it would be better if these differences were not so large.

Generally it is an object of this invention to provide improvements to assist in keeping more uniform temperatures in a mold using this general concept or at the least providing the public with a useful improvement in relation to molds.

DISCLOSURE OF THE INVENTION

In one form of this invention there is proposed a mold which includes an arrangement to assist in controlling of a temperature of the mold including at least one closed chamber within the mold, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means by reason of heat exchange to effect condensation of vapour within the chamber, the mold being characterized in that the liquid is arranged, in use, to be distributed in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.

In preference the different heights of liquid are achieved by having at least one reservoir within the chamber with a bottom of the reservoir being above a bottom of the chamber.

In preference as an alternative the different heights are achieved by having the liquid being applied as a surface application onto an inner surface of the chamber and above a base level of liquid within the chamber.

In preference as an alternative the different heights are achieved by having a passageway with some of the liquid in the passageway where an inlet at least to the passageway is above a base upper level of liquid in the chamber.

In preference as an alternative the different heights are achieved by having the liquid selected or having an additive whereby to effect a foaming.

In one form of this invention this is achieved by having a liquid which is adapted to foam during use of the mold.

A surprising discovery is that in one of the alternative approaches by having the liquid arranged to foam as the liquid is being caused to boil results in the liquid rising as foam containing vapour of the liquid to significantly extend the liquid as a film through the chamber. This then coats the walls of the chamber with liquid.

This has a result of wetting and keeping wetted the inner surfaces of the chamber above any base level of liquid in the chamber so that implicitly the height of the

liquid being only a film adhering to the surface of the wall of the chamber will not reflect any substantial head.

In preference in this example the liquid is predominantly water and the foaming agent is a surfactant.

In trials conducted so far, the results have indicated a significant improvement in the use of water to maintain uniformity of temperature especially when the temperature is relatively low such as temperatures in the vicinity of 25 degrees Centigrade. If there were to be a significant head of water then the water at a bottom of this head is under the additional pressure of the head of water and will "boil" at a higher temperature which can be higher than that which is ideal in some cases or unacceptable in other cases.

This then also allows for the quantity of water needed in the chamber and which will normally form a base quantity of liquid to be reduced from what had previously been considered to be necessary. This then allows for the chamber to be of substantial depth without there inevitably being a head of liquid with such height that there will be caused an unacceptable boiling temperature difference of water at a top of a body of water as compared to water at a bottom of the body of water. There are other forms of achieving different heights of liquid within the chamber which will be further expounded.

In preference there is in the chamber, means to effect passage of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereunto.

Such an effect can be alternatively described as a situation where a vapour lock occurs.

In a further form in preference there are provided means to hold some of the liquid in a reservoir which is, therefore, in conjunction with the size and shape of the chamber and the quantity of liquid in the chamber, providing a head of liquid for use for directing a stream or other flow of the liquid through one or more conduits into places which would otherwise be inaccessible to liquid by reason of vapour lock occurring.

In a further arrangement there is provided a substantially upright conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in the chamber.

The addition of a foaming agent has the advantage that once boiling occurs anywhere within the liquid, this foam and the water as a film implicit in the foam will readily extend in the manner of foam through the chamber and thereby carry the small amount of water that forms the film forming the foam bubbles with it.

The physical quantity of water that is carried on the foam can be small. Even smaller quantities of liquid however, in the chamber (which will usually be water), will be sufficient because of the technique being used.

What we can have then is a relatively small amount of water with a relatively small amount of foaming agent such as a surfactant appropriate to create foam.

With water being the liquid, if air is then substantially removed from the closed chamber, then boiling will only occur when the temperature of the water is raised above that which will cause a boiling of the water within the defined vapour pressure then existing within the chamber.

If the quantity of water is very small so that it might amount only to perhaps a small percentage of the total volume of the chamber, then with appropriate design of the chamber, the maximum height of water within the chamber can be kept very small indeed. (This then forming a base level of liquid within the chamber.)

It has been found in practice therefore that using the feature of a foaming agent, allows for a significant reduction in the quantity of water necessary for the purpose of holding a more uniform temperature within the mold or other mold. On the other hand, it allows for large and complex molds to be designed with shapes including a cooling chamber or chambers that would normally not provide ready access for such cooling liquid.

Recalling that a significant advantage of the arrangement described is that it is now easier to maintain a working temperature of all parts of the mold within a selected variation over a working cycle of operation and over different parts of the mold it

becomes possible now to design molds where cooling techniques which were previously available would not have kept the temperatures within an acceptable or at least a preferred range of temperatures. This can assist with reduced cycle times for a molding process. Furthermore, this effectively eliminates corrosion from any oxidation in the cooling chamber.

The reason corrosion will be eliminated is that a closed chamber will enable the liquid to be used only where this has had oxygen removed, at least to a substantial extent and furthermore, will not have oxygen available by reason of substantial removal of air from the space within the chamber and above the liquid level.

Some features of some molds may need some additional assistance in maintaining continuing liquid access for cooling purposes.

This situation is the case where the chamber has a relatively long and narrow conduit shape noting that the word "conduit" means entry into but does not necessarily mean passage to anywhere else.

In such a case, the surface tension of the liquid such as water in relation to the surface of the chamber may impede continuing access of liquid into the conduit shape or in other words a situation where a vapour lock effect may otherwise result.

Accordingly, there is proposed that there be means to gather liquid within the chamber but at a height higher than an entry position into the conduit shape and means to effect through an injector conduit, a supply of such liquid through the injector conduit into the conduit shape.

A further arrangement for obtaining liquid at a head above the entrance to the conduit is to have a reservoir beneath an area providing for condensing of any vapour within the chamber and then have a conduit extending from such a reservoir down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.

With such a reservoir created, which can have then any number of conduits feeding from this into injector conduits as required, such a reservoir is arranged so as to be a relatively shallow reservoir which will quickly overflow in normal operations so as to return most of the liquid to a lower reservoir.

In an alternative arrangement, in preference there is provided a conduit which nonetheless forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding reservoir of the type previously described for feeding conduits to eventually feed injector conduits.

Further then, there is provided in an adjacent vicinity to this vertical conduit, a member to provide a source of heat targeted to any material within the vertical conduit.

The way in which the heat can be provided can vary significantly from an electrical resistance coil to a conduit connected to a hot water supply. This is a useful adjunct if additional lift of liquid is required in the circumstances of a specific mold.

However, with such an additional heat source, the effect within the conduit therefore is to effect a boiling of the liquid within the conduit and the result that liquid in the manner of a percolator is then lifted by the rising vapour from the inlet through to the outlet.

In a further preferred arrangement, the result is achieved by having one or more dams or reservoirs which hold a limited amount of the liquid and which are arranged to collect the liquid from time to time during the "boiling" of the liquid in the chamber either by reason of rapid transition to vapour effects causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

There can be also in preference a combination of foaming agent and distributed reservoirs or dams.

Further, the reservoir or dam or dams can be arranged to overflow as they are filled with the liquid and this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head pressure and therefore maintain a reasonably small range of temperatures at which the liquid will boil within any selected reservoir or dam.

In a further development, a surface material is applied to an inner wall of the chamber above a base level of liquid in the chamber, which surface material will

assist in retention of liquid in close vicinity to the wall providing thereby a further effective height for the liquid.

In one example, at least some parts of the inner surface of the chamber are coated with a material so that surface tension implicit between the liquid and the material will assist in continuing retention of the liquid against the wall.

In one example, flock in the form of a number of short strands of fibre are attached end on in close vicinity one to the other, to the surface so that liquid which reaches any such selected area thus treated, will be held to be of greater depth and therefore act as a greater reserve. This then allows for a greater tolerance in a refresh rate of liquid needed to keep the surface wet. In other words, the amount of liquid available will be greater than with a smooth surface and allow therefore more tolerance in any replacement of liquid that might be being used.

The replenishment of liquid mechanism can be variously a flow from vapour being condensed above the selected area and therefore seeping or pouring over the area, it can be caused by splattering or spraying from devices within the chamber, it can be subject to replenishment by rising foam, or it can be subject to replenishment simply by ebullient action of the liquid during any boiling action.

In preference then in a further form the invention then could be said to reside in a mold for molding of plastics material where there is a closed chamber using the heat transfer system described to effect a transfer of heat, characterised in that at least some of the surface of the chamber has attached thereto further material or materials to assist in retention of the liquid in the adjacent vicinity of a target surface of the wall of the chamber.

In preference, the liquid is water.

In preference the foaming agent is a foam causing surfactant.

In preference, the materials added are a flock which is adhered by an appropriate adhesion process so that the respective particles of flock are secured end on to the surface of the chamber.

In preference, the thus treated surface is replenished with water from time to time during an operation of the mold by liquid being supplied from above.

In another example, replenishment is effected by foam causing film of the liquid to pass across the selected surface area wetting this thereby.

In another form of this invention this can be said to reside in the method of effecting heat transfer within a closed chamber for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

Temperatures of a mold depend to some extent upon the thickness of the metal between the heat source (e.g. a molding surface) and the selected area within the closed chamber. If there is a greater thickness, then there will be a temperature gradient that depends on the various characteristics of the metal of the mold and the respective temperatures at each side. This can be taken advantage of in allowing some parts of a molding surface to be at a different temperature than others.

One problem with such an arrangement is that, because it relies upon an evacuation of the space within the chamber, if for any reason, there is a leak reducing or removing the evacuated state of the space, then this is a status that needs to be rapidly and reliably discernible by an operator.

I have discovered a very reliable and economic arrangement by which such status can be readily determined.

In preference there is further proposed that there be a passageway connecting with the liquid in the chamber which is closed at an upper end and which has at least a portion which can be seen through to the extent that any liquid level within the passageway can be externally determined, and the position of the passageway including its entry and its closed upper end, is such that a level of liquid within the passageway will change from a first level where a first evacuation status within the chamber exists, to a second level where the degree of evacuation within the chamber is less than the first said evacuation status.

In effect then, it is proposed that there be a "sight glass" although its purpose is to indicate a state of evacuation and not to indicate directly at least, any level of water or other liquid within the chamber.

The advantage of the invention arises in so far that when the space within the chamber is evacuated, this will result in an equivalent drawdown of liquid level within the closed passageway.

Where the evacuation of the main chamber is compromised however, this will also then reflect in the conditions within the closed passageway and the level of water or other liquid will then appropriately rise.

There can be then any appropriate further detector of such liquid level so as to provide an automated warning or otherwise.

However, by use of the very simple and ultimately reliable use of the arrangement described, it now becomes a much improved system with the ability to monitor the status of the evacuation.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of this invention it will now be described with reference to preferred embodiments which shall now be described some with the assistance of drawings wherein:

Figure 1 is a perspective view with part cross section of one part of a plastics injection mold including an inner chamber according to a first embodiment,

Figure 2 is a cross section of a part used in a further form of the invention,

Figure 3 is a cross sectional view along the lines 4-4 in Figure 4 of a second embodiment,

Figure 4 is a cross sectional view of a second embodiment,

Figure 5 is a cross section of a third embodiment, and

Figure 6 is a cross section of a portion of a mold according to a fourth embodiment which shows a visual indicator of evacuation status of a chamber.

BEST MODE FOR CARRYING OUT THE INVENTION

Now referring in detail to the drawings and in particular Figure 1 there is shown here one part or half of a plastics material injection mold 1 where this one half of the mold has a quite arbitrarily chosen shape with a pin 2 extending from a middle of the molding shape 3. A mold to be fully operational will have a further part (which is not shown) forming in this case a female receiving shape which further part will have its temperature controlled with an arrangement and method substantially the same as this first part.

In this first part, then, there is a chamber 4, which is arranged to be closed and to have water inserted therein and air removed.

The extent of removal of air (which in this case is achieved by applying a vacuum pump (not shown) to closable outlet 4a through a wall of the mold) such that substantially all of the air is removed so that only the vapour of the liquid in the chamber substantially fills any remaining chamber area. The liquid which is water in a preferred embodiment is first treated so that substantially all dissolved gases have been removed by, for instance, vigorously boiling the water at standard atmospheric pressure prior to insertion into the chamber 1. If a vacuum pump is used to evacuate air however, such dissolved air can also be removed subsequent to the water being introduced into the chamber 4 by use of the vacuum pump.

In either case the procedure to reduce dissolved gases has the added advantage that the water will be substantially without oxygen when in the closed area of the chamber and therefore deterioration of any metal surface by reason of oxidation (e.g. rust) which will ordinarily occur in existing systems will now not occur in so far that there is not a source of oxygen.

In this embodiment, a small quantity of household detergent is added to the water, the quantity being dependent on the actual detergent being used but generally is a quantity that will result in adequate foaming under the mold operating conditions. In the case of experiments so far, 1% by volume of household detergent (one example being a domestic detergent sold under the Trade Mark of Morning Fresh

by the company Cussons Pty Ltd ACN 004 164 827 in Australia) has been added to the water. Alternative foaming agents can be used.

In order to reduce temperature differentials it has been found that if a quantity of water is held with the same head height, then the temperature, in these reduced pressure circumstances, at which the water will boil will depend on the level or more accurately the depth within any water at which boiling of that particular portion of water will take place. If a head of water created by a specific depth is above 200 mm (e.g. 300 mm) then the temperature difference is found to be of significance. Accordingly if the quantity of water is chosen to not then fill the chamber to a height greater than approximately 200 mm then this is found to provide reasonable temperature uniformity. A temperature range between 20 degrees Centigrade and 30 degrees Centigrade may in some cases be considered sufficiently uniform although in other cases a smaller range can be required and can be met by this invention and the principles espoused. The actual temperature difference required can be established and designed for.

By having the water foam, this then has the result of effectively lifting in a film, water to extend as foam through the higher parts of the chamber 4. Any such foam bubbles then will collapse randomly at higher levels with the result that water from such film will splatter onto adjacent surfaces. This then keeps these various surfaces wet in a way which therefore allows such water to boil at a temperature established by the fact that the water is surface water without any overlying head to change its boiling temperature.

Use of foam then allows for most of the surfaces defining the chamber 4 to be kept wet by collapsing foam bubbles.

Further in Figure 1 this has a shallow trough 5 which is positioned immediately below heat exchanger 6 which is arranged to be kept cool by cooling water passing through the heat exchanger 6 and therefore effecting condensation of vapour rising in the chamber 4. The condensate is directed into the trough 5 and as it overflows the water will run down the side of the mold part 1 into a main body of liquid (water with detergent).

However, a further percolator arrangement 7 is also in place to feed water into the trough 5. This has a vertical tube 8 with an inlet 8a at a bottom of the chamber in order to draw liquid into the tube 8 and an outlet 9 by which to direct lifted water into

the shallow trough 5. A source of heat 10 is arranged alongside the tube 8 and this is provided with an electric resistance element so the quantity of heat can be easily controlled and therefore the quantity of liquid that will be lifted with this arrangement.

The value of having a higher level of liquid is that the height can be used to push liquid into places it otherwise might be impeded from going, for instance by reason of surface tension effects. In this case the example is a narrow passage 11. In this we have a needle injector 12 inserting liquid which is running down through tube 14 into the passage 11 where small quantities of liquid are squirted into the narrow passage so as to splash and coat the inner surface of the passage with water. This water is then delivered by a higher level of pressure but on delivery the water is allowed to simply coat the surface. This then allows the effect to keep the temperature of even a small part within a mold to within an acceptable degree of uniformity.

Details of the needle injector are shown in greater detail in Figure 2.

Clearly, the number of tubes and the number of needle injectors can be substantial where however the example is showing just one.

In Figures 3 and 4 the part shown is only one part of a plastics injection mold and a matching other part or parts will have its or their own temperature distribution arrangement.

Here we have then a chamber 15 which has a plurality of cascading reservoirs 16 and 17 which are fed by liquid returning from the condenser area 19. In this way the liquid is at different heights above a base level within the chamber. Each reservoir 16 and 17 is shaped so that only a selected depth of water will stay in a respective reservoir and hence keep a temperature uniformity. The reservoir in each case is defined by walls 20 which are arranged to allow for overflow of the liquid when filled and such that the overflowing liquid will flow into the next reservoir underneath the first reservoir. The drawing shows an arrangement where however the water may to some extent follow an inward inclination of the wall 20 by reason of surface tension and therefore be directed as a cascade into the next reservoir beneath the first. As can be seen therefore, the head of liquid in any reservoir is determined by the height of water in an individual reservoir and as such this can now be determined by a mold designer appropriate to any application.

In the cases of the described embodiments these are used with the liquid having foaming agent so that some of the advantages of both answers can be achieved in a single mold.

In a further embodiment some of the surface of the chamber has attached thereto a flock which is adhered by an adhesive so that the respective particles of flock are secured end on to the surface of the chamber.

Use of flock enables a greater quantity of liquid to be held in the adjacent vicinity of the inner surface of the chamber in the mold.

Temperatures of a mold depend to some extent upon the thickness of the metal between the heat source (e.g. a molding surface) and the selected area within the closed chamber. If there is a greater thickness, then there will be a temperature gradient that depends on the various characteristics of the metal of the mold and the respective temperatures at each side. This can be taken advantage of in allowing some parts of a molding surface to be at a different temperature than others.

In Figure 5 there is shown an injector system 40 which has a passageway 41 with an open top 42 positioned in a chamber 43. There is a narrow mold part 44 which is arranged to be fed water through the passageway 41. The open top is at a height somewhat above the height of the part 44 so that any water in the passageway will be forced through the passageway to its lowermost outlet 45. By having such an open top 42 with simply violent boiling of the water together with assisted lifting of the water through a foam assisted action will result in water splashing into the open top 42 and hence feeding the passageway. The mold 46 is again a part of an plastics injection mold with a condenser 47 located in a space 48 above a base level of any liquid 49.

Again then there is described an arrangement where there is distribution of liquid in a way that reduces effects of head of water and therefore causing different boiling temperatures.

Referring to Figure 6, one of the problems with the arrangement described is that if for some reason the evacuated state of the chamber is compromised e.g. a leakage occurs, then an operator needs to know this so that the mold is not further operated until the status is corrected. The problem however is how to reliably and

cheaply determine that the evacuated status is being maintained. There is an answer that is both economic and reliable which shall now be further described.

In Figure 6 then there is shown a mold 21 for injection molding of plastics materials where there is within this, a chamber 22 which is arranged to hold water 23 and the shape of the chamber 22 is such that it will be located adjacent heat generating locations within the mold 21.

There is an opening into the chamber 22 at 24 by which air can be evacuated from a space 25 above the water in accordance with my earlier invention.

The feature of this embodiment is that there is a passageway 26 connected to a main body of the water which passageway 26 progresses from a main body of the chamber to an external viewing location where the passageway is a vertical riser and where a top of the passageway at 27 is closed.

The passageway 26 in this case is formed as a part of the mold except there is embedded within the external surface of the mold a transparent window 28 so that the height of liquid within the passageway will be visible to an external viewer.

With this arrangement then, the effect previously described will be observable which is that the level 30 of the liquid will be an indication of the status of evacuation within the main space of the main chamber 22. If this is changed then this will be observable to an operator who can then establish whether a leakage into the main chamber has occurred and then take appropriate action.

The height of liquid within the closed passageway will be a reflection of the evacuation status of the chamber overall.

What has now been described will allow the design of molds (or molds or other molds) with the ability easily to keep temperatures within a more uniform range than hitherto and the invention described is considered to be of groundbreaking importance in the art.

CLAIMS

1. A mold which includes an arrangement to assist in controlling of a temperature of the mold including at least one closed chamber within the mold, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means by reason of heat exchange to effect condensation of vapour within the chamber, the mold being characterized in that the liquid is arranged, in use, to be distributed in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber.

2. A mold as in the preceding claim further characterized in that the different heights of liquid are achieved by having at least one reservoir within the chamber with a bottom of the reservoir being above a bottom of the chamber.

3. A mold as in either one of the preceding claims further characterized in that the different heights are achieved by having the liquid being applied as a surface application onto an inner surface of the chamber and above a base level of liquid within the chamber.

4. A mold as in any one of the preceding claims further characterized in that the different heights are achieved by having a passageway with some of the liquid in the passageway where an inlet at least to the passageway is above a base upper level of liquid in the chamber.

5. A mold as in any one of the preceding claims further characterized in that the different heights are achieved by having the liquid selected or having an additive whereby to effect a foaming.

6. A mold as in claim 1 further characterized in that the liquid includes a foaming agent .

7. A mold as in any one of claims 1or 2 further characterized in that the liquid is predominantly water and the foaming agent is a surfactant.

8. A mold as in any one of the preceding claims further characterised in that there is a passageway of liquid into a passage forming a part of the chamber having dimensions where surface tension of the liquid would otherwise inhibit passage of liquid thereinto.

9. A mold as in any one of the preceding claims further characterized in that there is at least one reservoir for liquid in the said chamber which is adapted to hold liquid so that a head of liquid in such a reservoir is less than the height of such liquid above other liquid in the chamber.

10. A mold as in any one of the preceding claims further characterized in that there is provided a substantially vertical conduit with a lower inlet and an upper outlet and a heat source adjacent a part of such conduit, and a means to hold any liquid lifted through the conduit by boiling of liquid effecting a percolator type effect, at a height above a normally existing upper level of liquid in the chamber.

11. A mold as in the immediately preceding claim further characterized in that there are means to gather liquid within the chamber but at a height higher than an entry position into a conduit shape and means to effect through an injector conduit, a supply of such liquid through the injector conduit into the conduit shape.

12. A mold as in the immediately preceding claim further characterized in that there is a reservoir beneath an area providing for condensing of any vapour within the chamber and a conduit extending from such a reservoir down into the injector conduit which has an aperture through which the liquid then will flow at a rate depending upon the head of liquid and the size of the conduit.

13. A mold as in any one of the preceding claims further characterized in that there is provided a conduit which forms a part of the closed chamber which has an inlet at a lower position within the chamber such that this inlet will be below a normal liquid level within the chamber, and an upper outlet which will direct liquid into a holding reservoir.

14. A mold as in the immediately preceding claim further characterized in that there is provided in an adjacent vicinity to the conduit, a means to provide a source of heat.

15. A mold as in any one of the preceding claims further characterized in that there is provided at least one dam or reservoir which holds a limited amount of the liquid and which is arranged to collect the liquid from time to time during the boiling of the liquid in the chamber either by reason of rapid transition to vapour effects causing substantial ebullition and therefore implicit lifting of the liquid to appropriate heights, or by reason of condensate being directed to one or more of the dams or reservoirs.

16. A mold as in any one of the preceding claims further characterized in that the reservoir or dam or dams are arranged to overflow as they are filled with the liquid and this cascading effect can ensure that each of the reservoir and dams are kept to only a selected level and therefore head pressure and therefore maintain a reasonably small range of temperatures at which the liquid will boil within that selected reservoir or dam.

17. A mold as in any one of the preceding claims further characterized in that there is applied, a surface material to an inner wall of the chamber.

18. A mold as in the immediately preceding claim further characterized in that at least some parts of the inner surface of the chamber are coated with a material such that surface tension implicit between the liquid and the material will assist in continuing retention of the liquid against the wall.

19. A mold as in preceding claim 17 further characterized in that flock in the form of a number of short strands of fiber is attached end on in close vicinity one to the other, to the surface so that liquid which reaches any such selected area thus treated, will be held to be of greater depth and therefore act as a greater reserve.

20. A mold for molding of plastics material where there is a closed chamber using the heat transfer system described to effect a transfer of heat, characterised in that at least some of the surface of the chamber has attached thereto further material or materials to assist in retention of the liquid in the adjacent vicinity of a target surface of the wall of the chamber.

21. A mold as in the immediately preceding claim further characterized in that the liquid is water.

22. A mold as in the immediately preceding claim further characterized in that

the foaming agent is a foam causing surfactant.

23. A mold as in any one of the preceding claims further characterized in that replenishment is effected by foam causing film of the liquid to pass across the selected surface area wetting this thereby.

24. A mold as in any one of the preceding claims further characterized in that there is a passageway connecting with liquid in the chamber which passageway is closed at an upper end and which has at least a portion which can be seen through to the extent that any liquid level within the passageway can be externally determined and the position of the passageway including its entry and its closed upper end, is such that a level of liquid within the passageway will change from a first level where a first evacuation status within the chamber exists, to a second level where the degree of evacuation within the chamber is less than the first said evacuation status.

25. A method of effecting heat transfer within a closed chamber of a mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and where the liquid level is at different heights within the chamber.

26. A method of effecting heat transfer within a closed chamber of a mold for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of the liquid within a space above the liquid within the chamber, and where a surface of the chamber selected for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

27. A method of effecting heat transfer within a closed chamber for the purposes described where the method includes having within the closed chamber only liquid, and the vapour of liquid within a space above the liquid within the chamber, and where a surface of the chamber or condenser for purpose of extracting heat therefrom is above a level of the liquid within the chamber and effecting replenishment of liquid in respect of that selected area from time to time

where the selected area includes a treatment to effect retention of the liquid by use of surface tension of the liquid.

28. A mold substantially as described in the specification with reference to and as illustrated by the accompanying drawings.

29. A method of effecting heat transfer within a mold substantially as described in the specification with reference to and as illustrated by the accompanying drawings.

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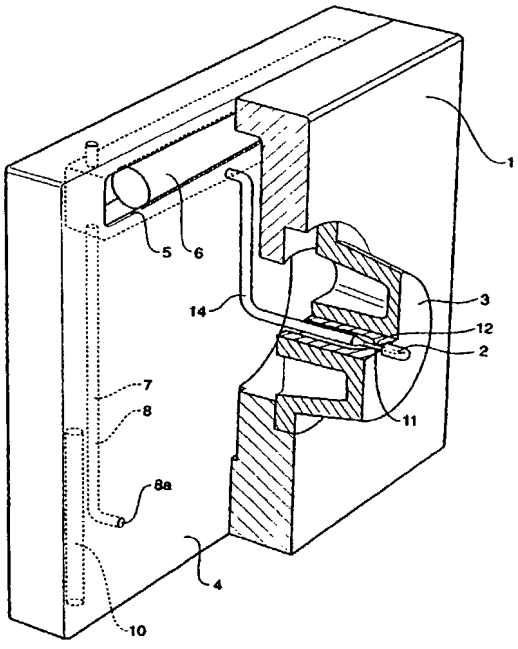

(57) Abstract: An arrangement to assist in heat transfer through a mold for applications such as injection molding of plastics material including at least one closed chamber within the mold, the chamber being only partially filled with liquid and a remainder of the chamber being filled with substantially only vapour of the liquid within the chamber, at least a portion of the chamber being positioned to transmit heat from a targeted location of the mold into liquid within the chamber, and condensing means adapted by reason of heat exchange to effect condensation of vapour within the chamber, the mold being arranged in that the liquid such as water is arranged to be held in the chamber in such a way that the liquid will be distributed to reach or be held at different heights within the chamber. This is achieved in one case by the addition of a foaming agent in the liquid. In another case by having a flock attached to the inner surface of the chamber. In a further example there are separate tiers of reservoirs holding the liquid above a base level of the liquid.

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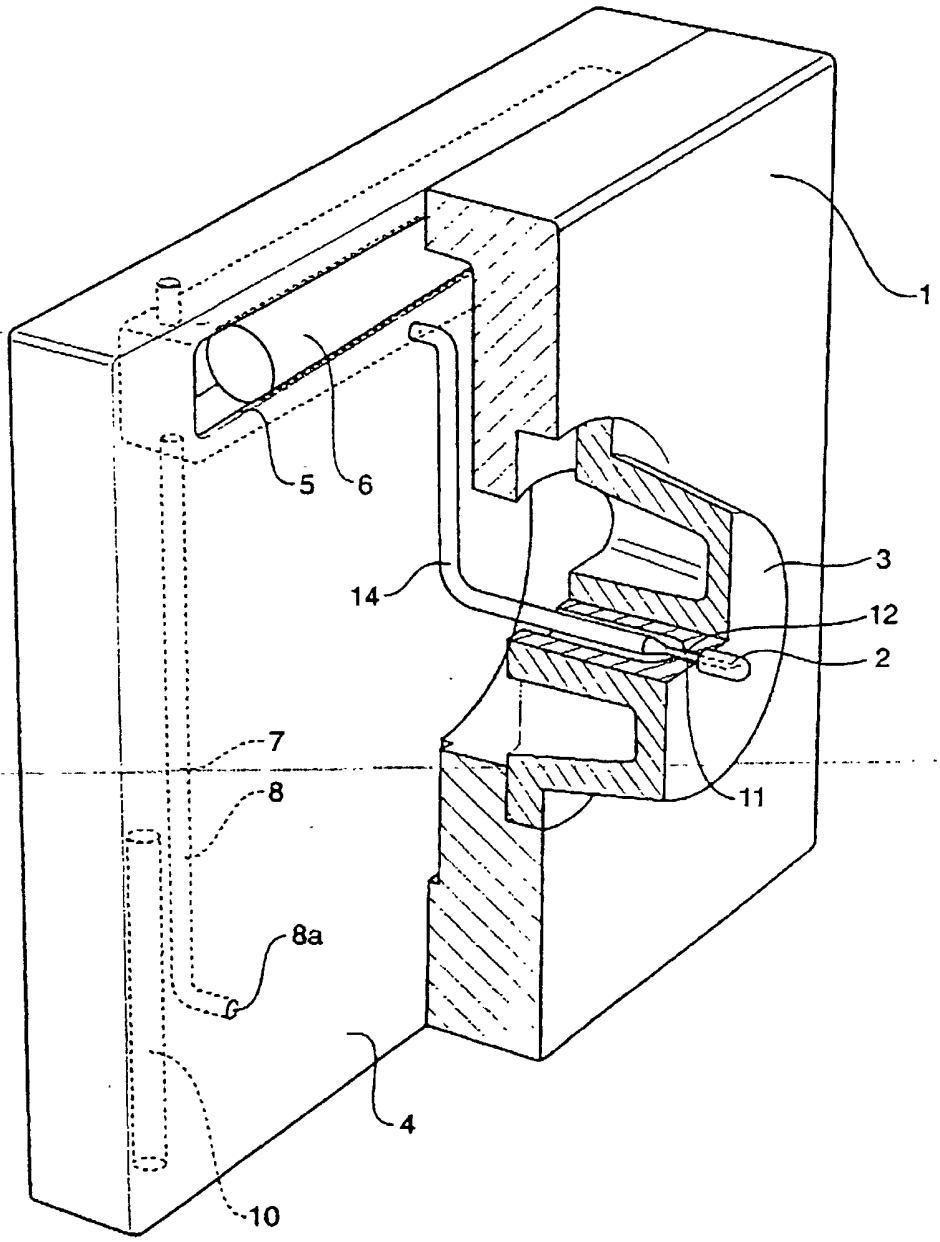

Fig 1

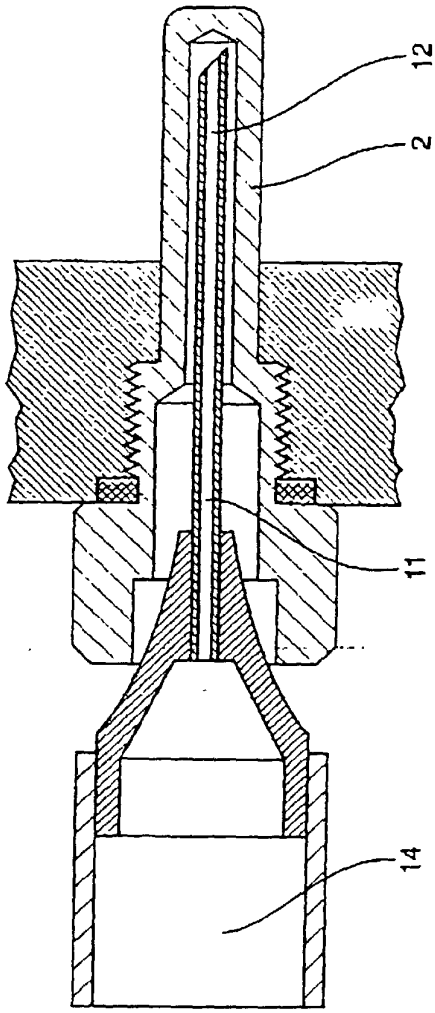

Fig 2

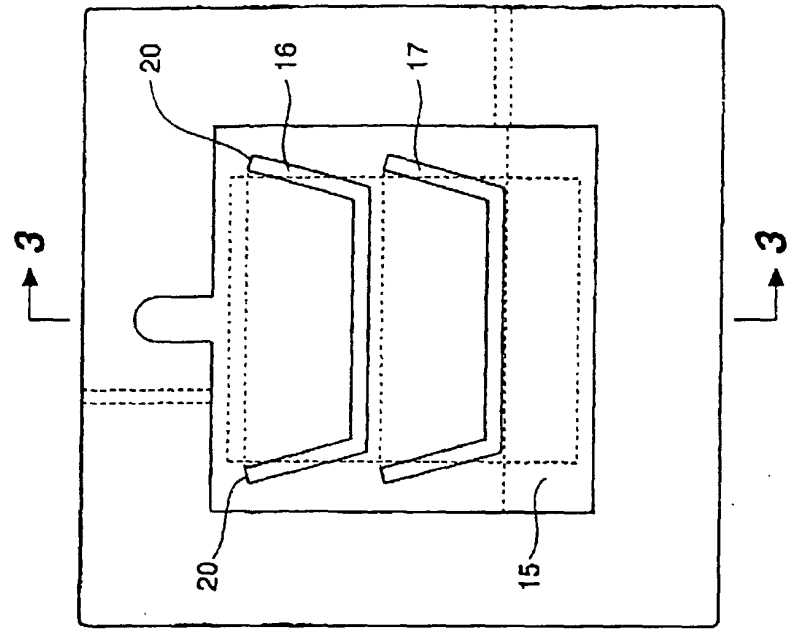

Fig 4

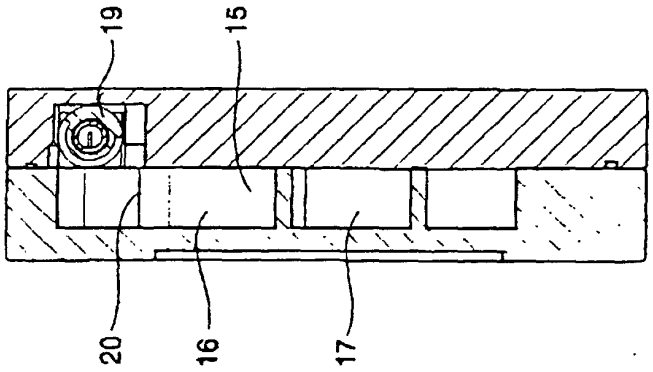

Fig 3

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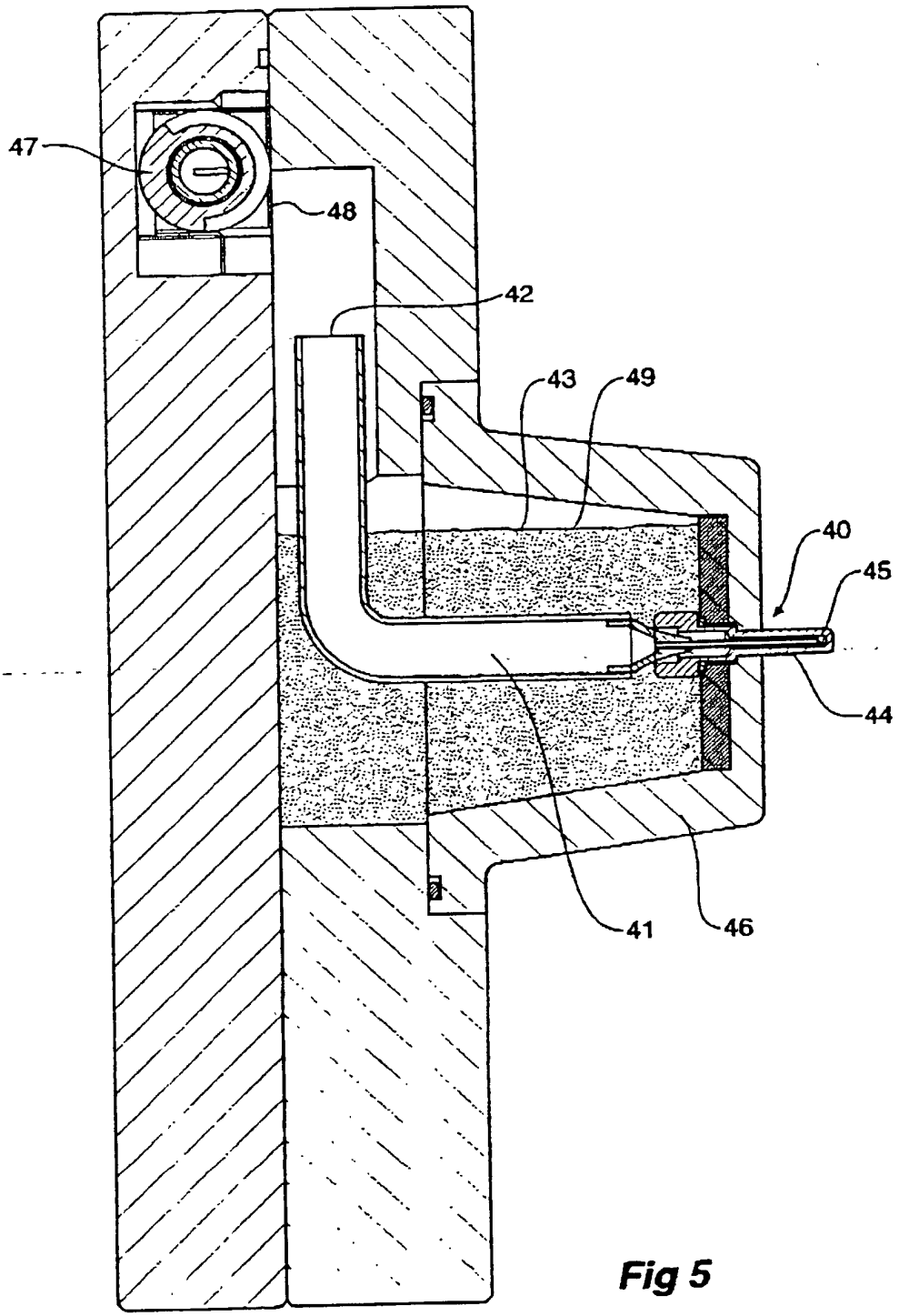

Fig 5

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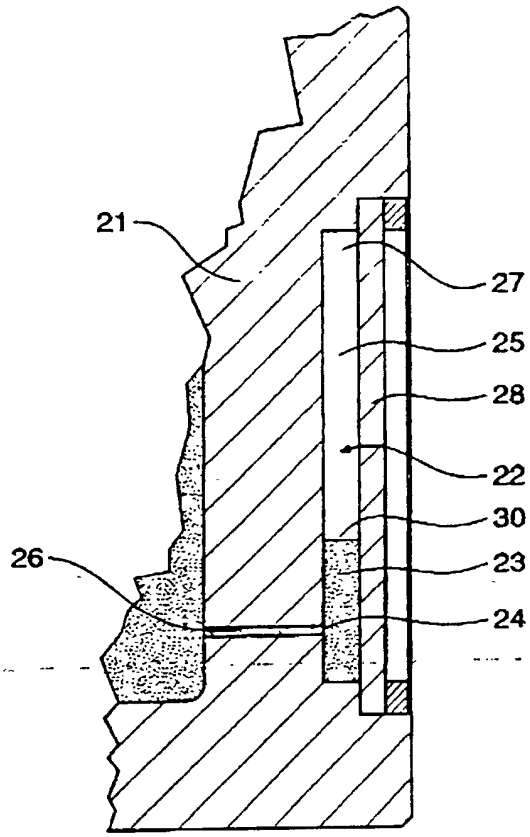

Fig 6

Attorney Docket No.: P-33/Colli.

POWER OF ATTORNEY

I hereby appoint the following attorney(s) and/or agent(s) to prosecute the application entitled COOLING OF MOLDS and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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State or Country	State or Country
Date	Signature

☐ Additional inventors are being named on separately numbered sheets attached hereto.

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UNITED STATES -- PATENT DECLARATION FOR PATENT APPLICATION

Attorney's Docket No.: P-33/Colli.

50865US HKS

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a design patent is sought on the invention entitled COOLING OF MOLDS , the specification of which

(check one) ☐ Is attached hereto.

☒ Was filed on March 22, 2002 as United States Application number or PCT Int'l Application No. PCT/AU00/01160 and was amended on _____ (if applicable)
and a pre-examination amendment was filed with the application.
Application Serial No.: 10/089121
and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

Application Number	Country	Date Filed	Priority Claimed
PCT/AU00/01160	Australia	25 September 2000	☒ YES ☐ NO
PQ3077	Australia	24 September 1999	☒ YES ☐ NO
PQ3334	Australia	11 October 1999	☒ YES ☐ NO

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status: Patented, Pending, Abandoned
		☐ Patented ☐ Pending ☐ Abandoned
		☐ Patented ☐ Pending ☐ Abandoned
		☐ Patented ☐ Pending ☐ Abandoned